Fighting Fire with Light: Tackling Extreme Terabit DDoS Using Programmable Optics

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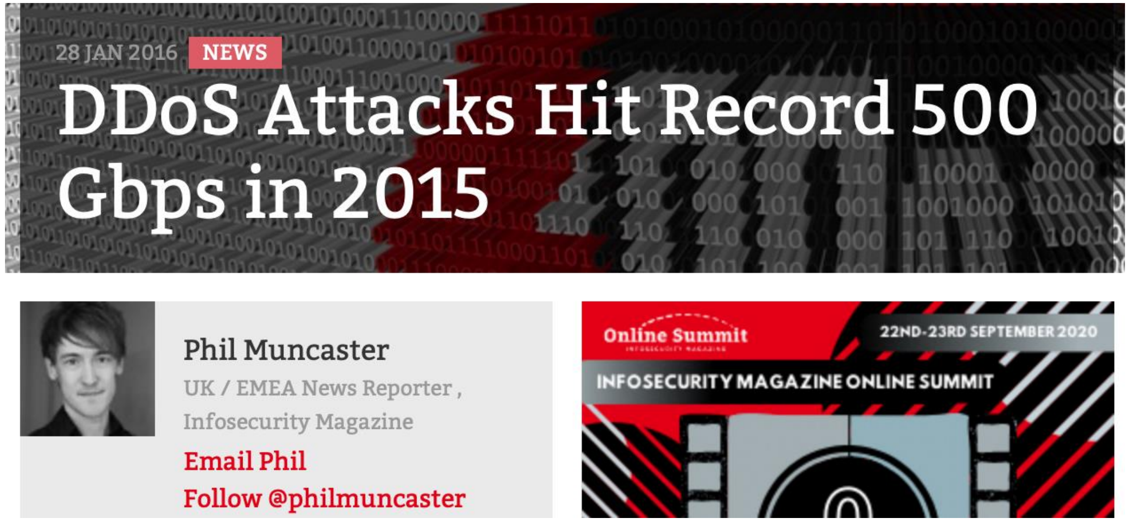
DDoS Attack Landscape is Changing



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DDoS Attacks Hit Record 500 Gbps in 2015

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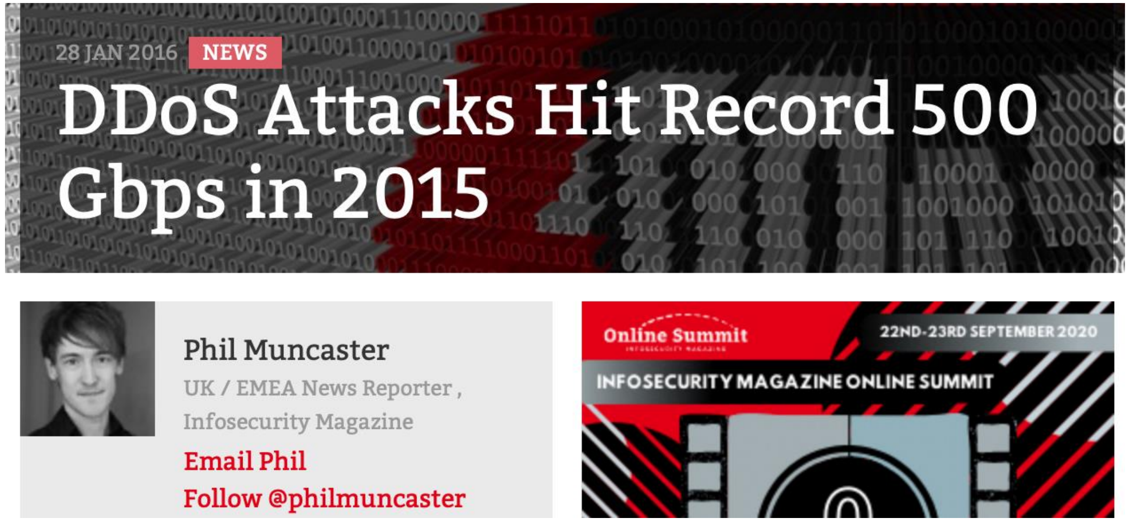

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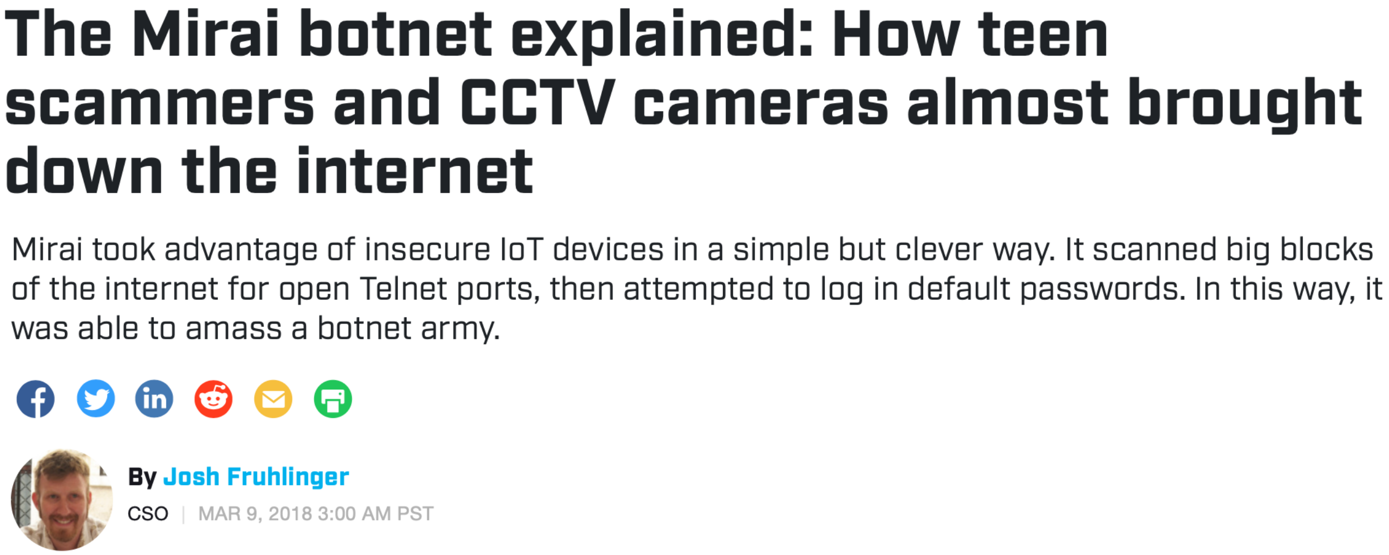

The Mirai botnet explained: How teen scammers and CCTV cameras almost brought down the internet

Mirai took advantage of insecure IoT devices in a simple but clever way. It scanned big blocks of the internet for open Telnet ports, then attempted to log in default passwords. In this way, it was able to amass a botnet army.

By Josh Fruhlinger
CSO | MAR 9, 2018 3:00 AM PST

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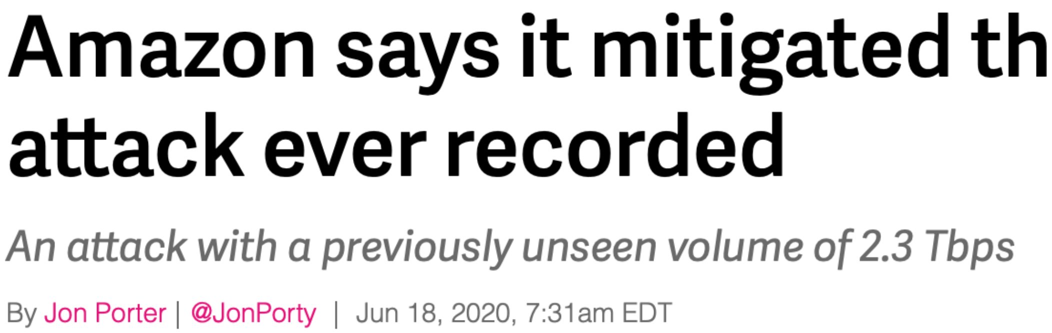
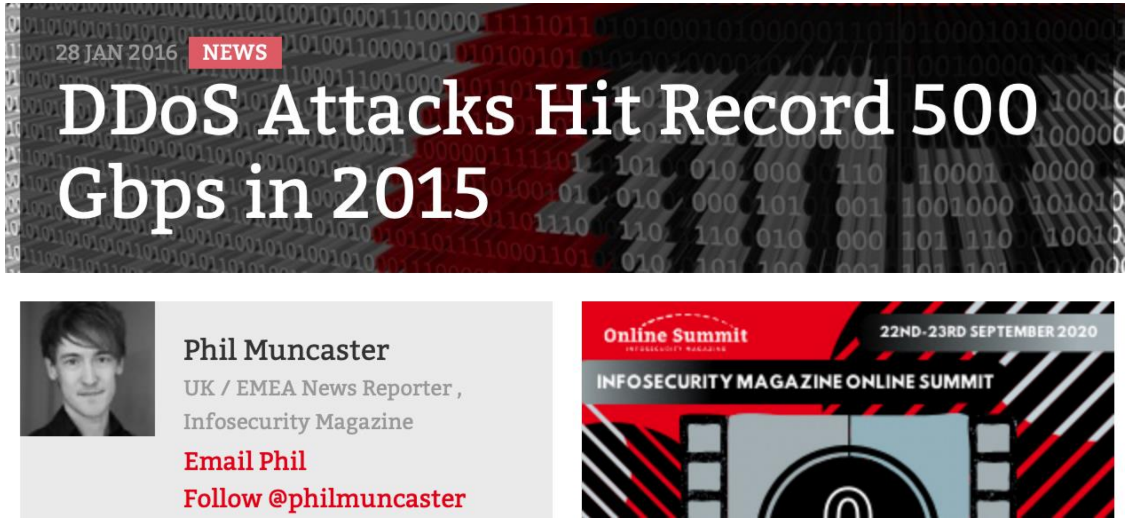


Amazon says it mitigated the largest DDoS attack ever recorded

An attack with a previously unseen volume of 2.3 Tbps

By Jon Porter | @JonPorty | Jun 18, 2020, 7:31am EDT



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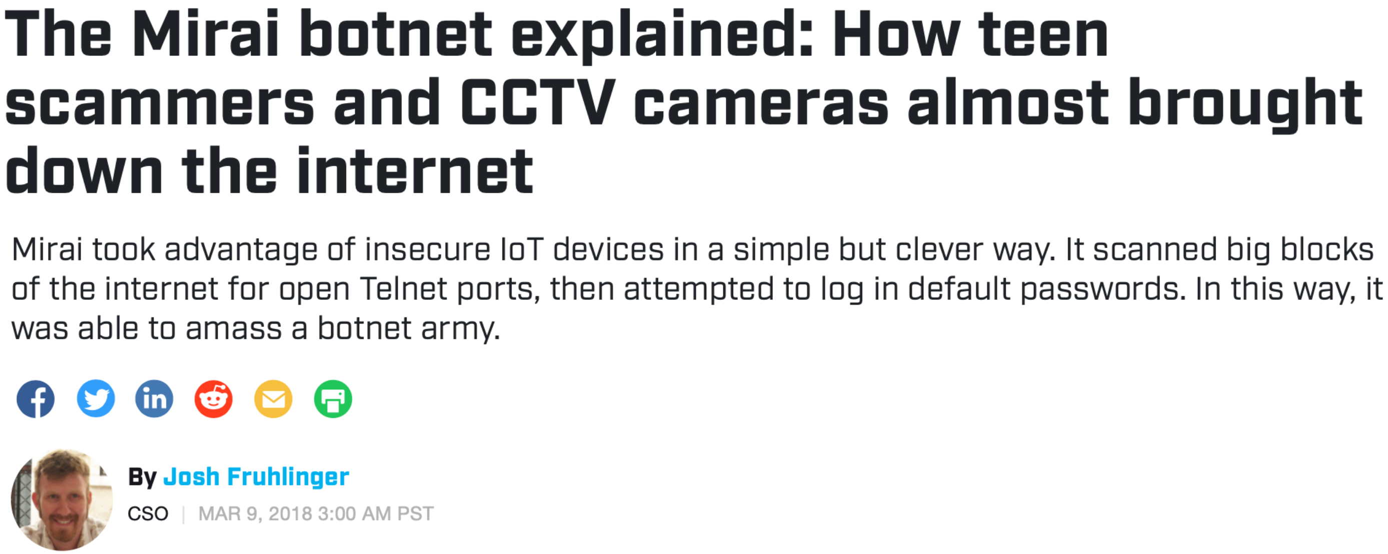

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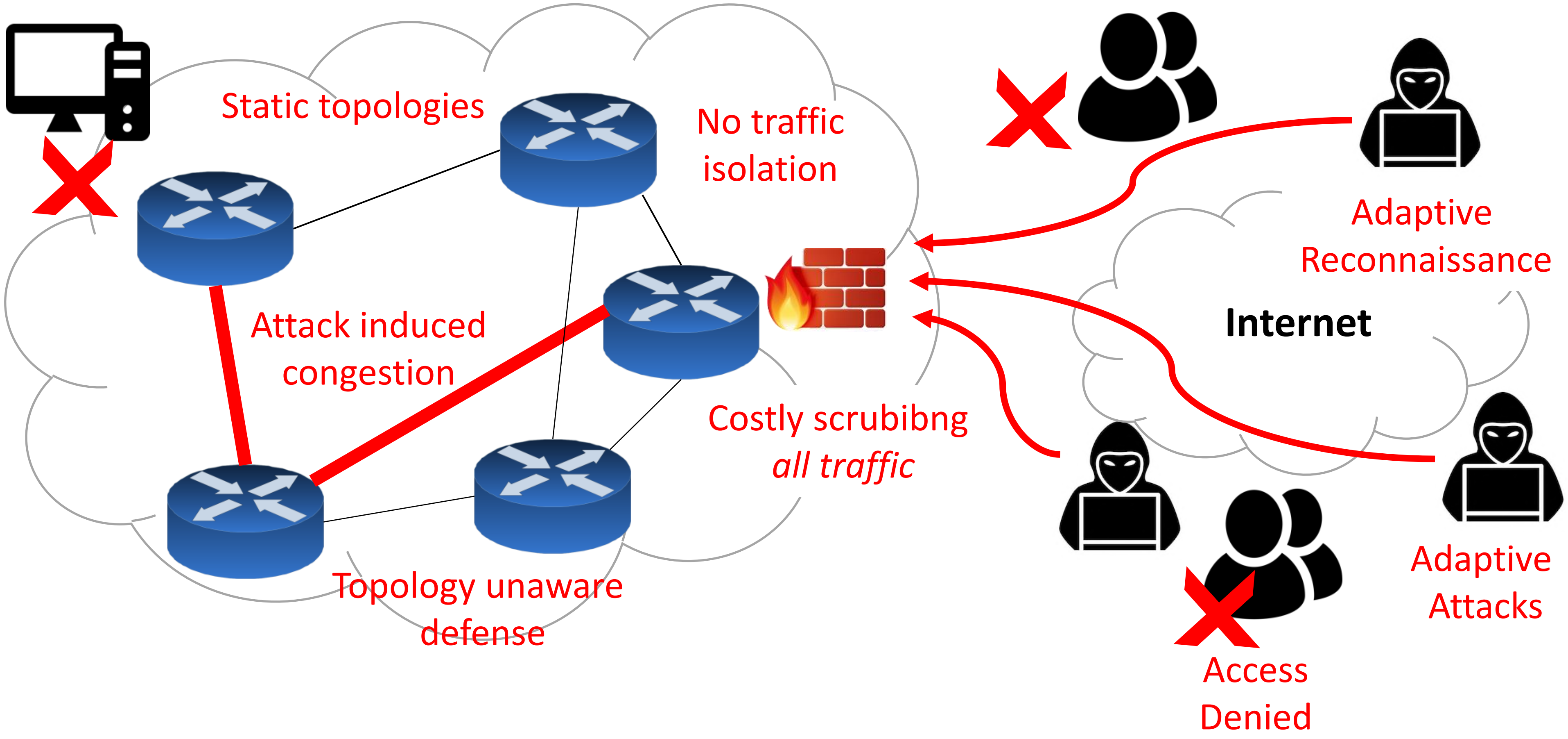
Limitations with Current State-of-The-Art



Our Goal

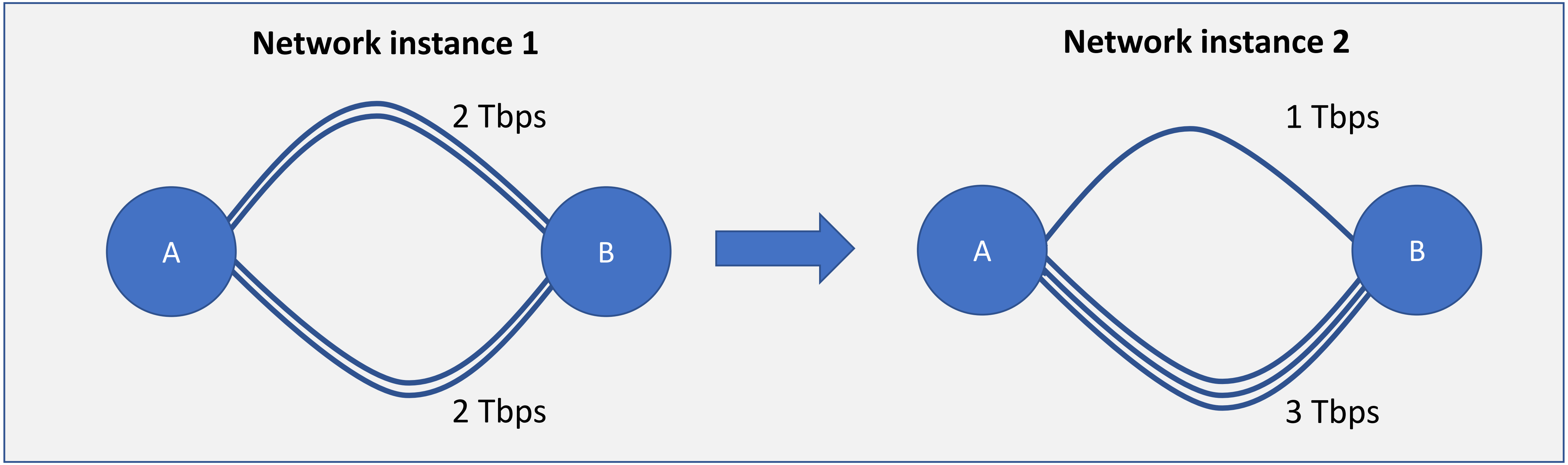
- Explore if DDoS defense system with programable optics can be beneficial and exciting to work on
- Illuminate two key benefits of such a system
  - Opportunistic reconfigurability
  - Physical separation of distinct traffic classes
- Present modeling results that quantify the performance benefit granted by programmable optics during a DDoS attack

An Untapped Resource

- Single-mode optical fiber underpins nearly all wide-area communications systems
- Reconfigurable Add/Drop Multiplexers enable the steering of individual wavelengths on a fiber rapidly
- Optical amplifier modeling efforts point to a rapidly reconfigurable backbone soon

What are Programmable Optics?

- Programmable optics enable bandwidth to be reallocated onto adjacent paths within a network through *transitions* between *network instances*



Opportunity 1

- Opportunistic Reconfigurability

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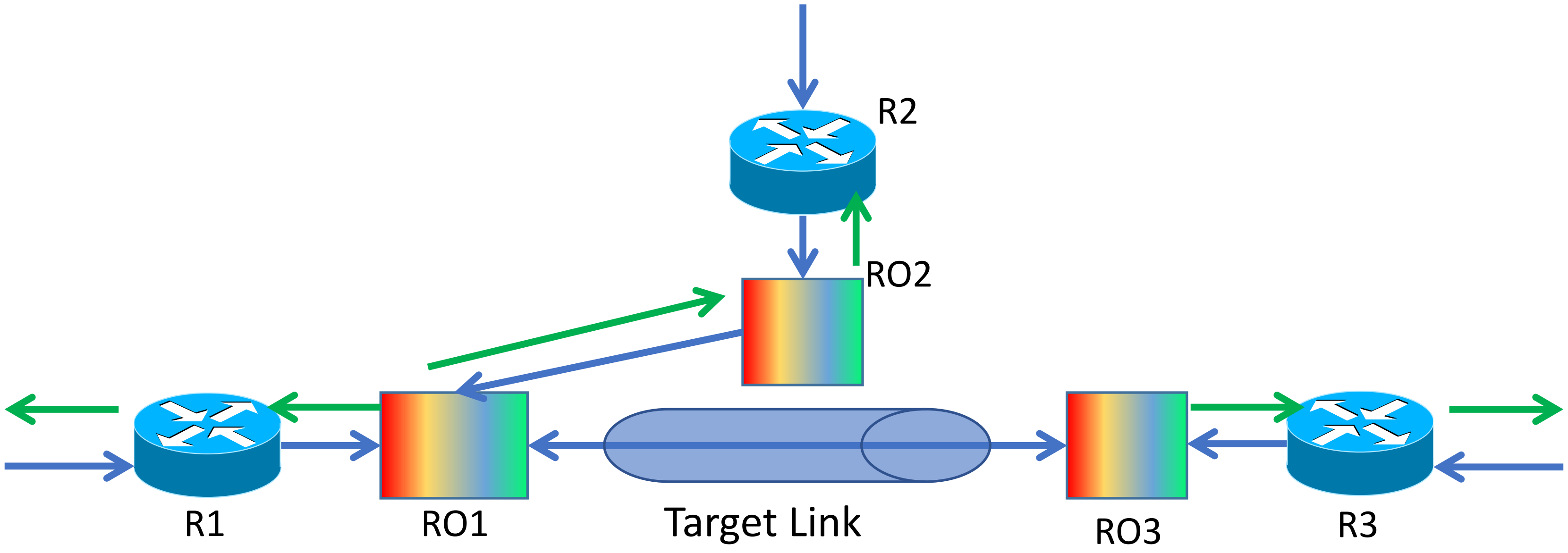

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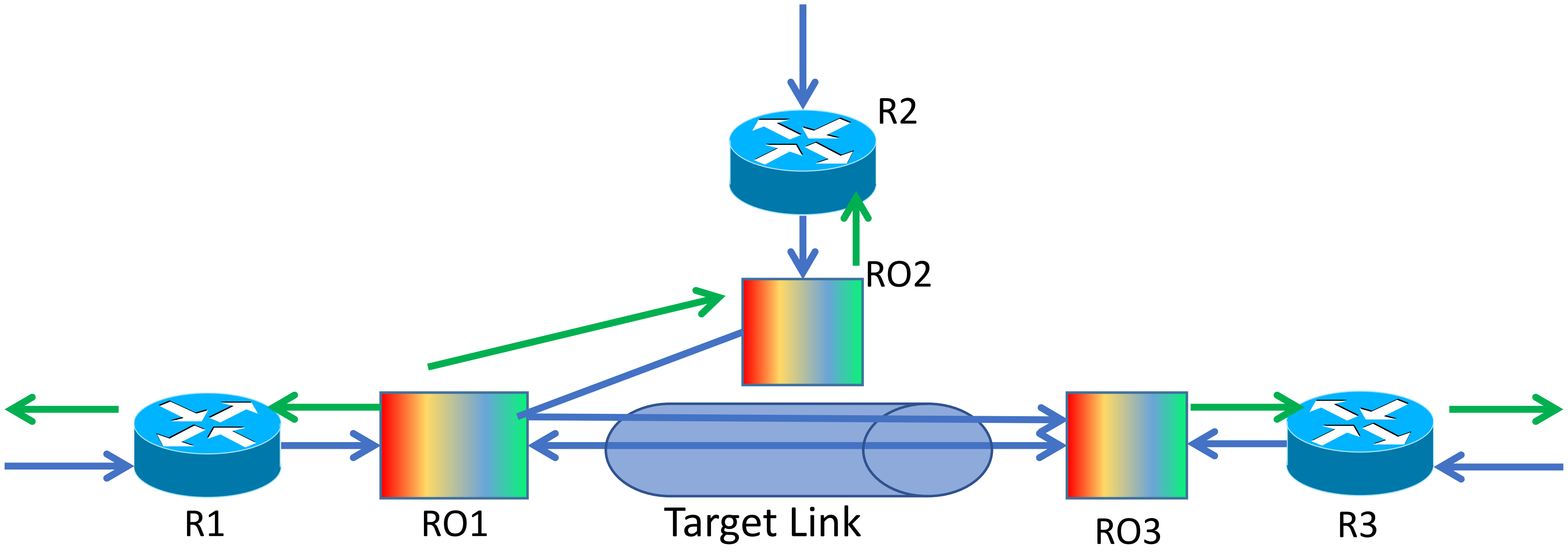

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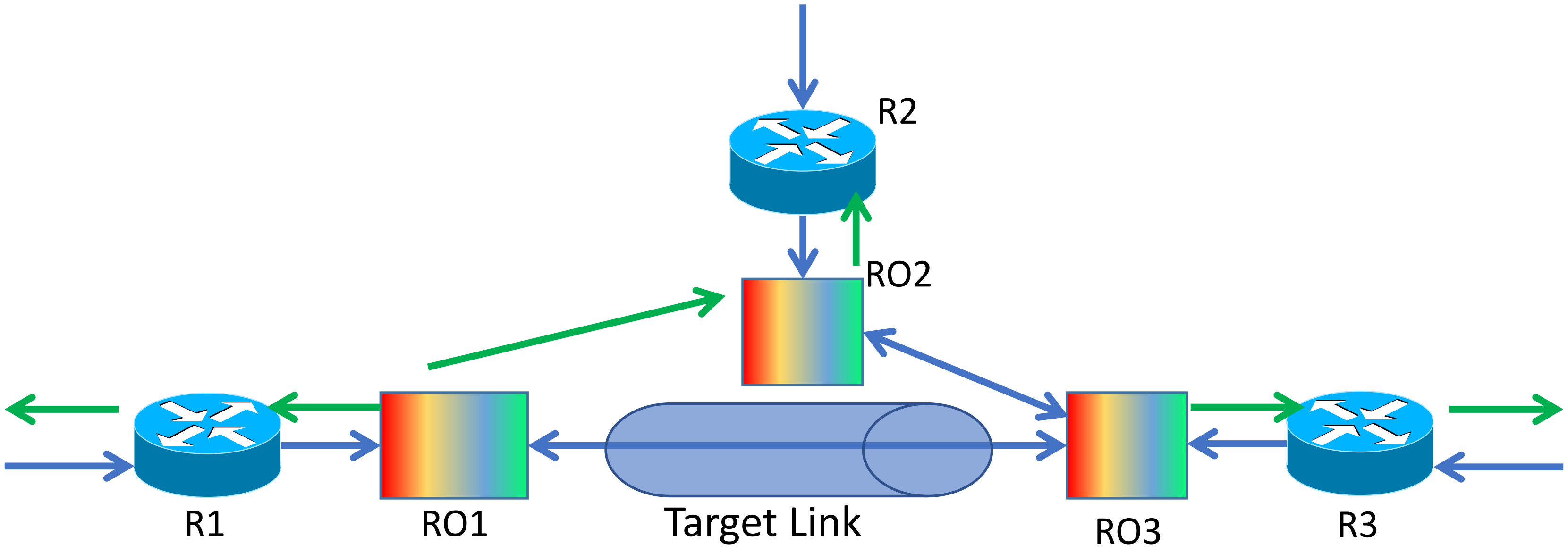

Opportunity 2

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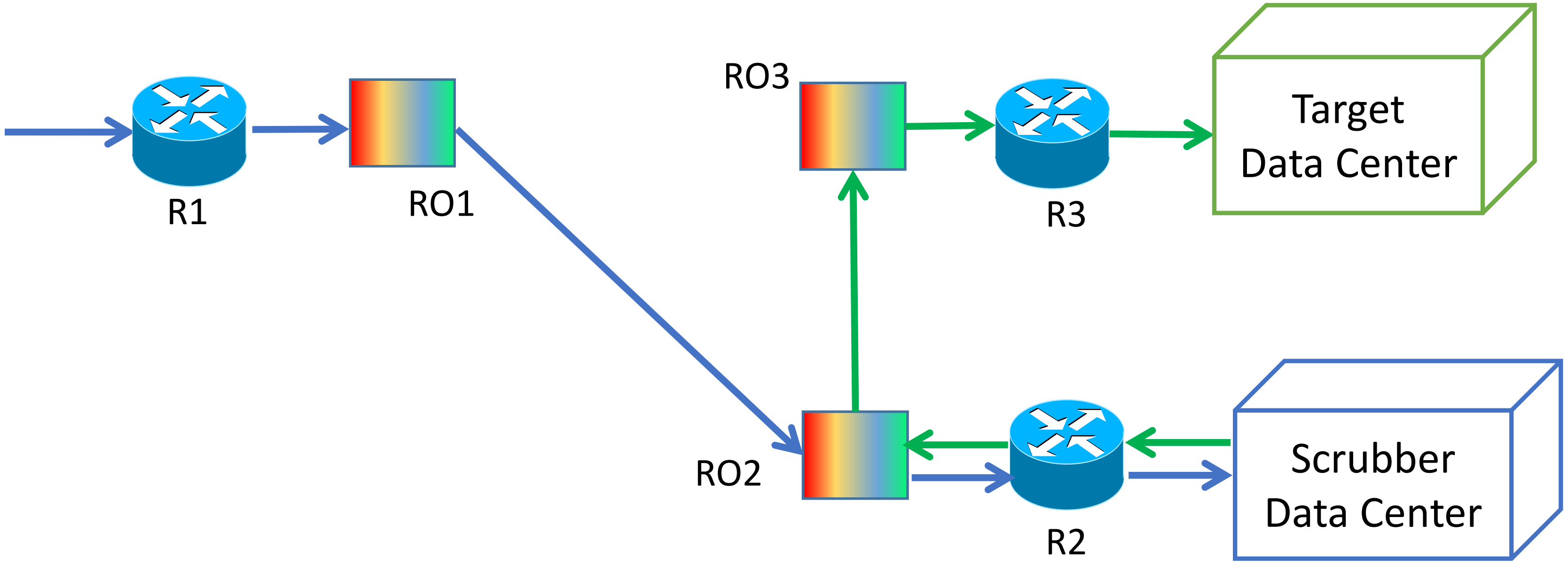

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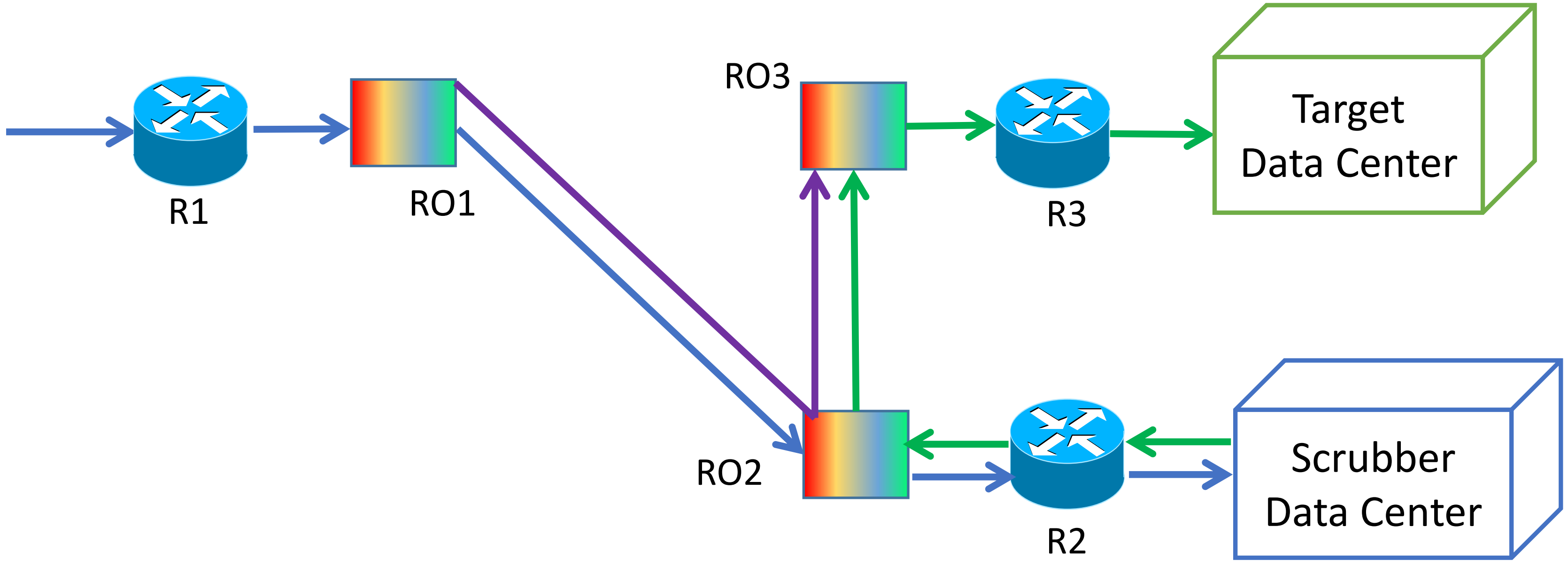

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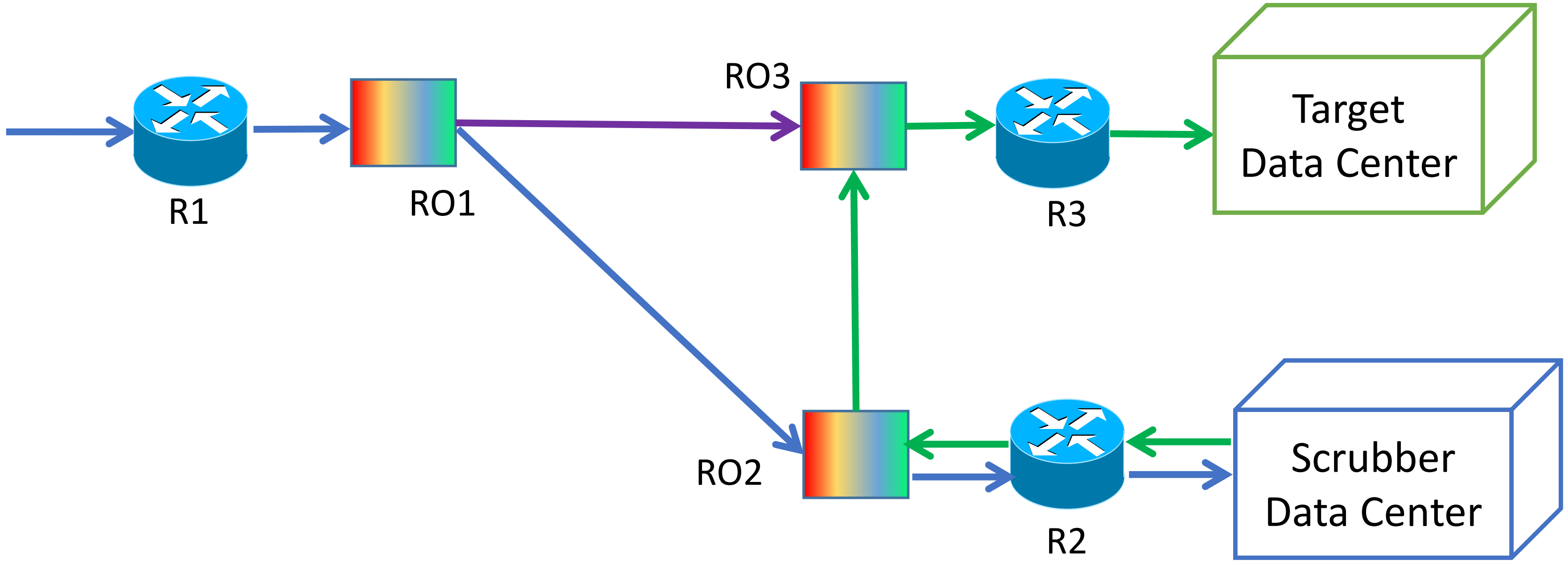
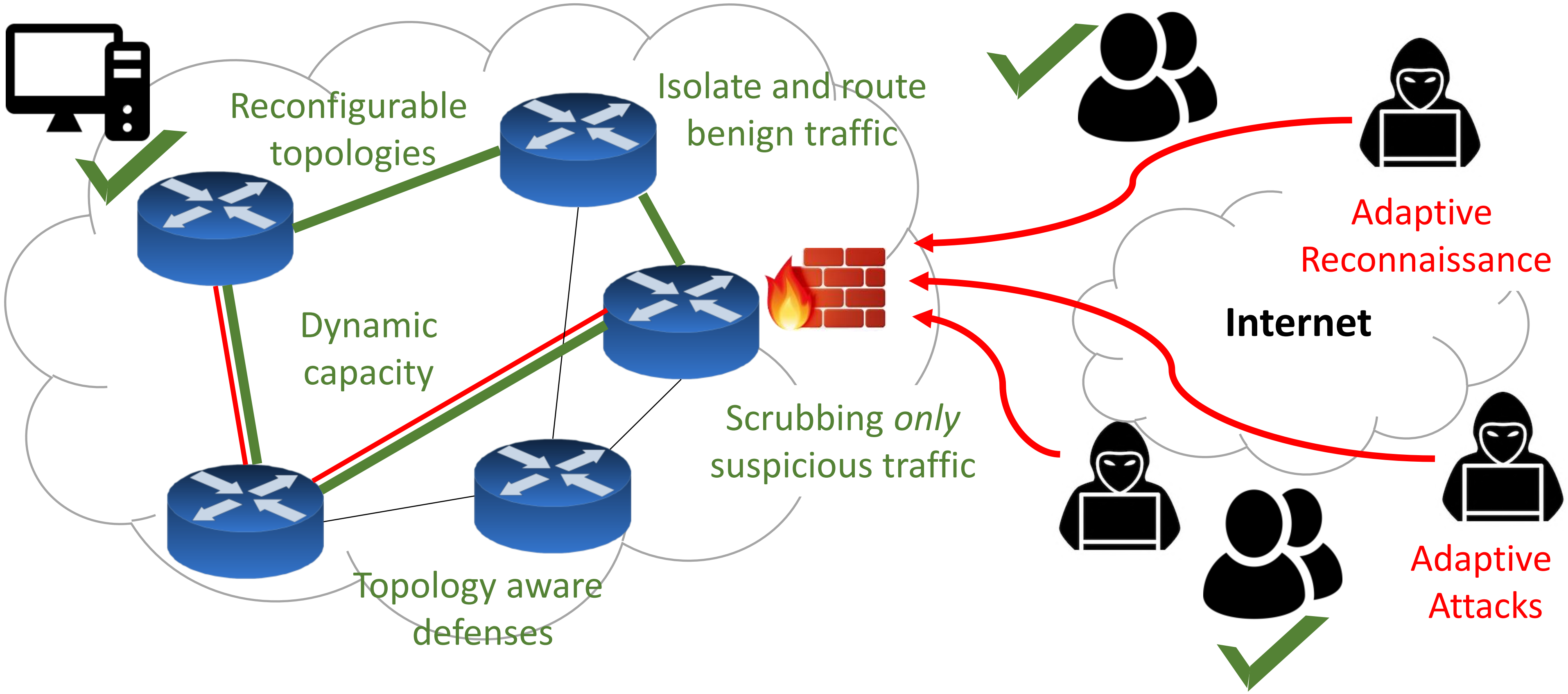
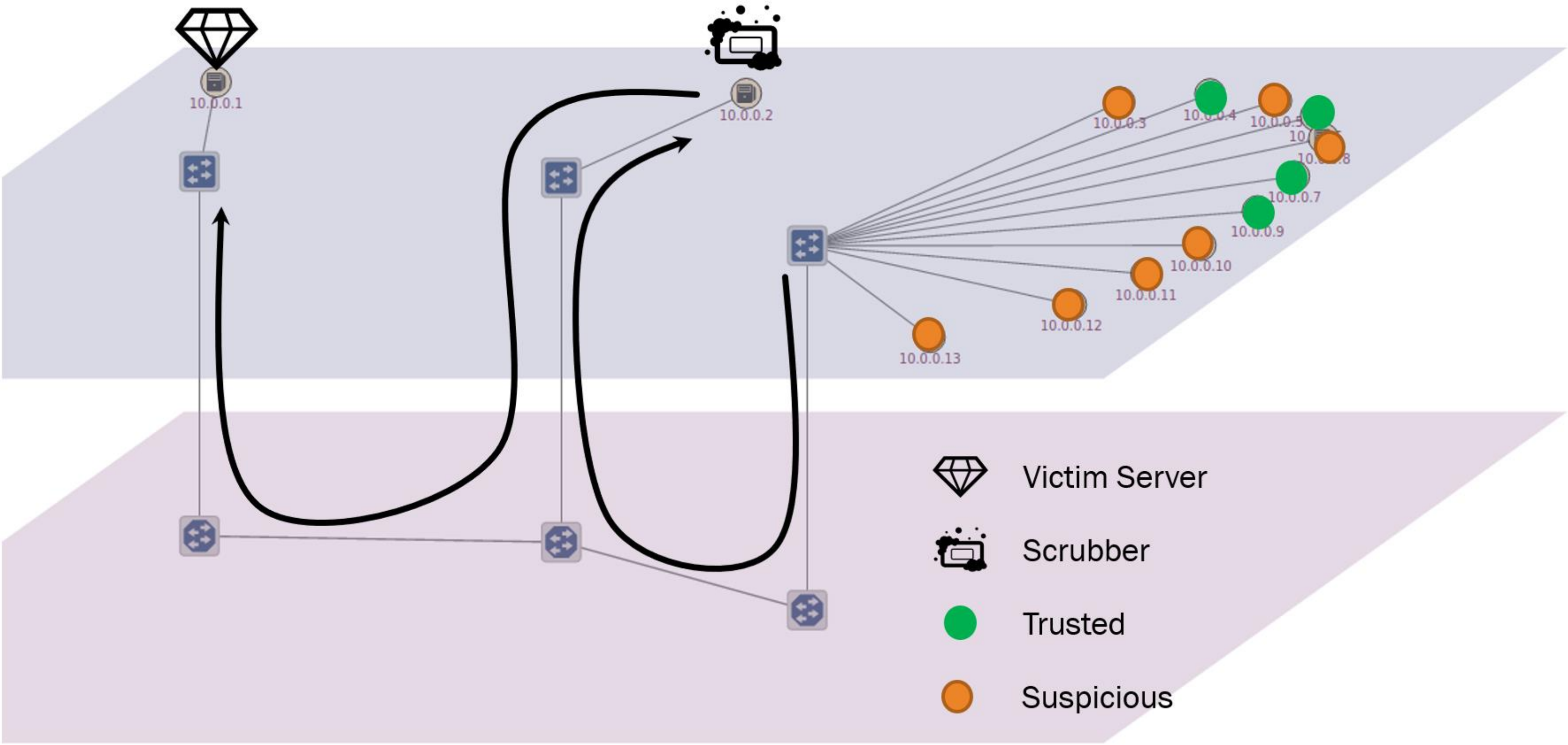


Optics-enabled In-**N**etwork defen**S**e for **E**xtreme **T**erabit DDoS attacks


Reconfigurable topologies
Isolate and route benign traffic
Dynamic capacity
Scrubbing *only* suspicious traffic
Topology aware defenses
Adaptive Reconnaissance
Internet
Adaptive Attacks

Performance limitation with Static Optics



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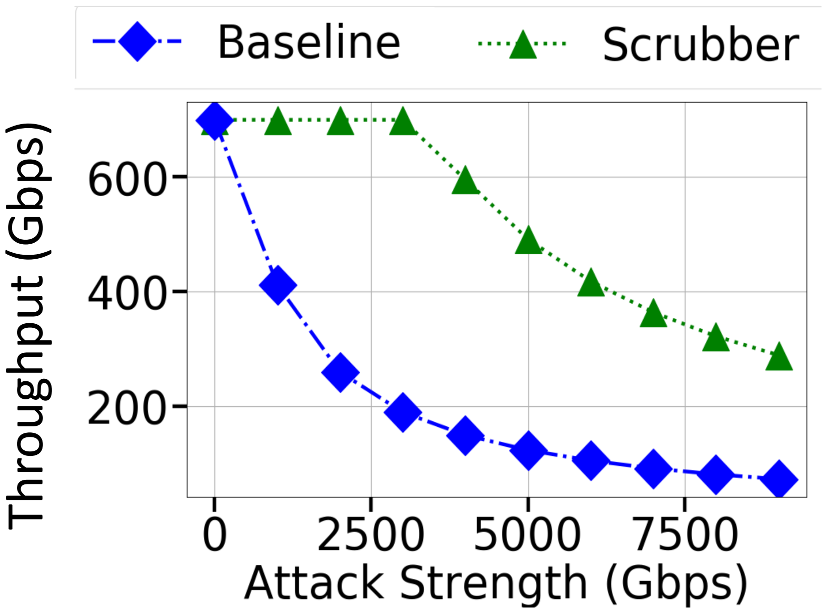
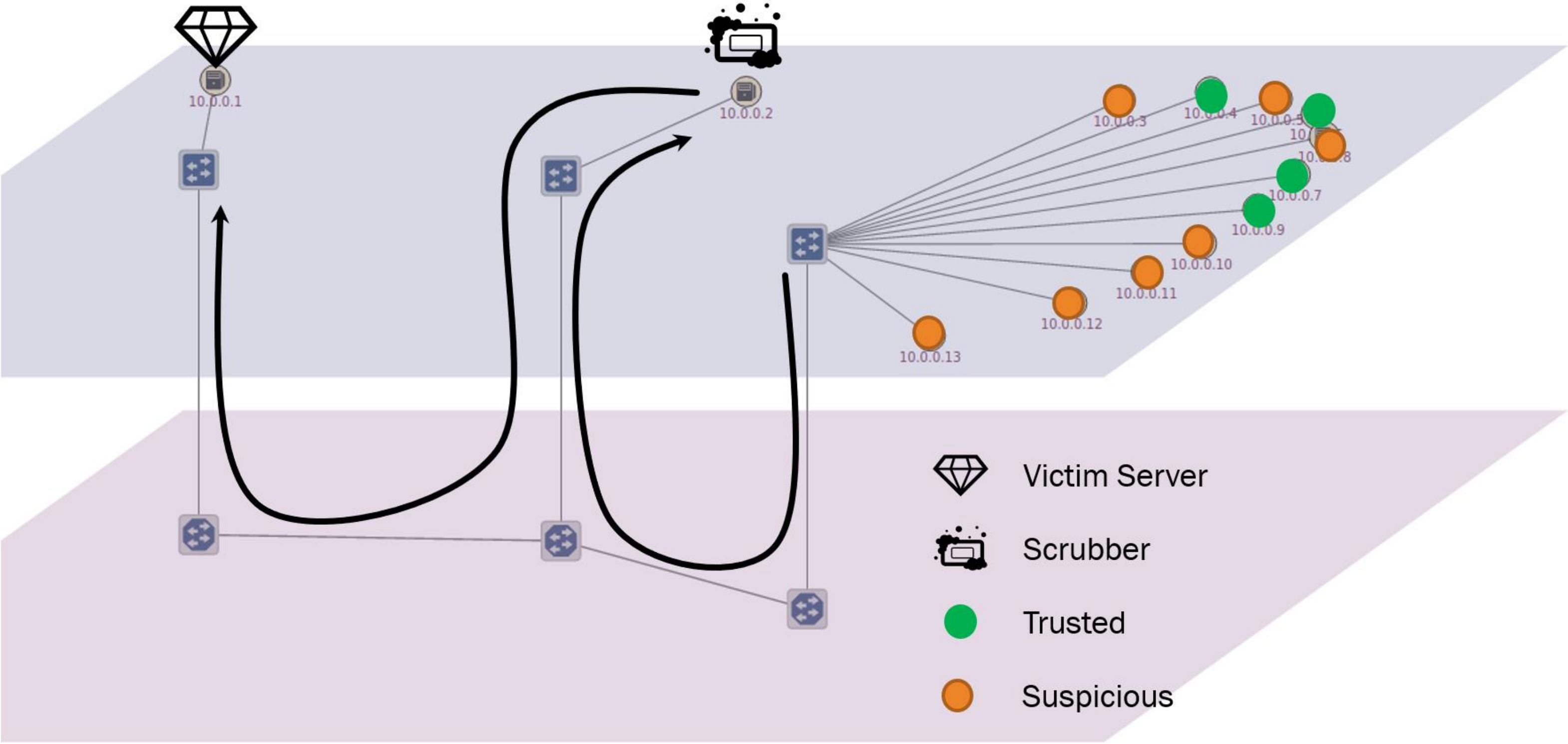
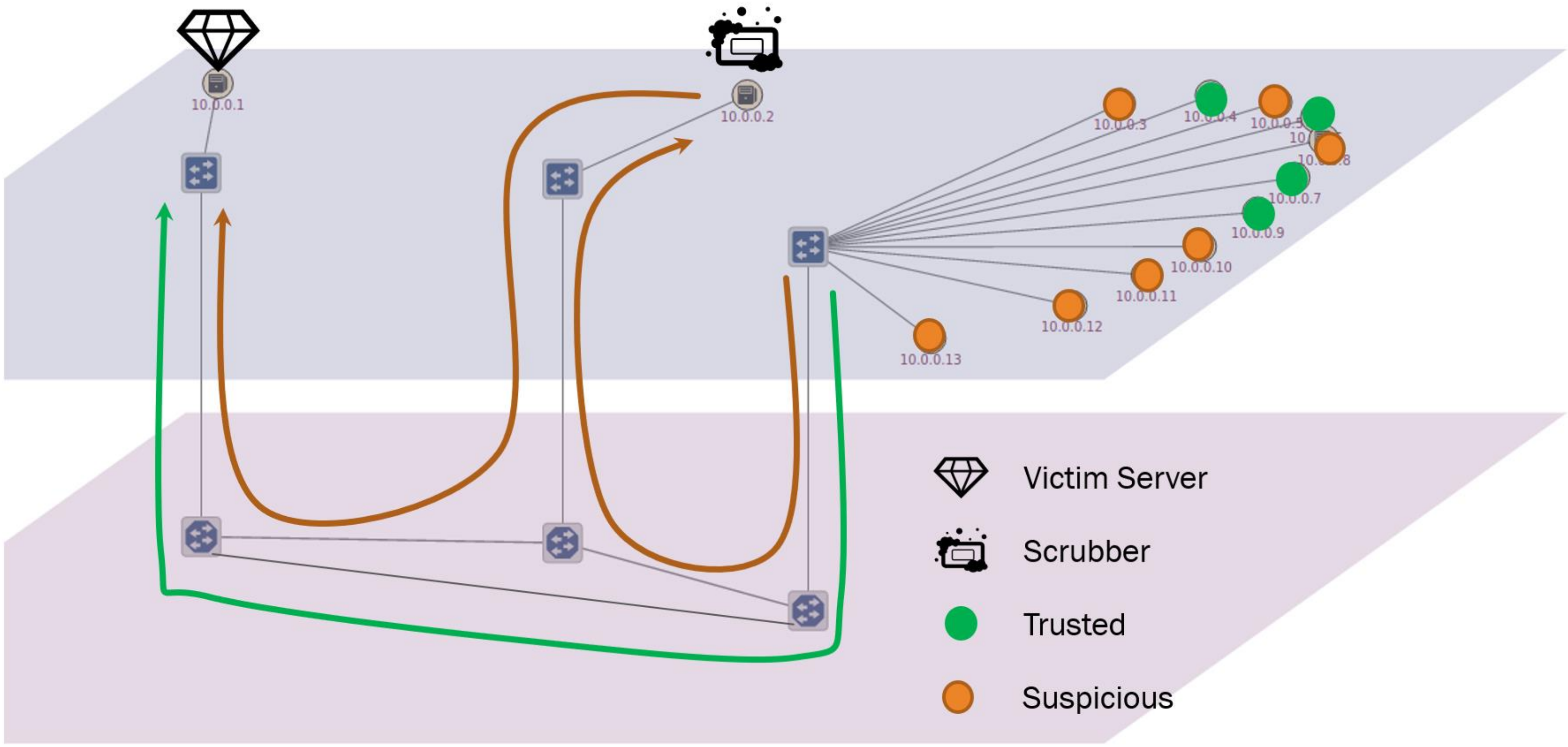




Performance gain
with Programmable Optics



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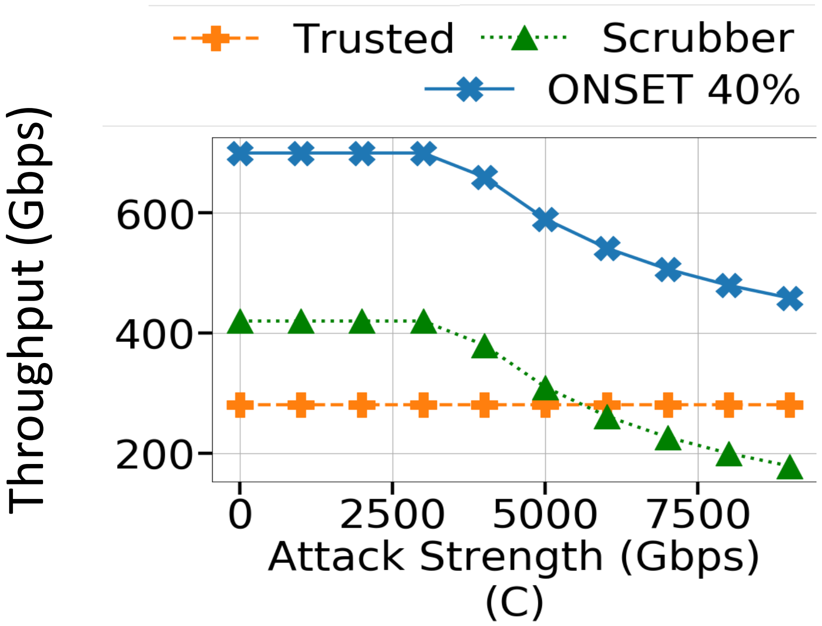

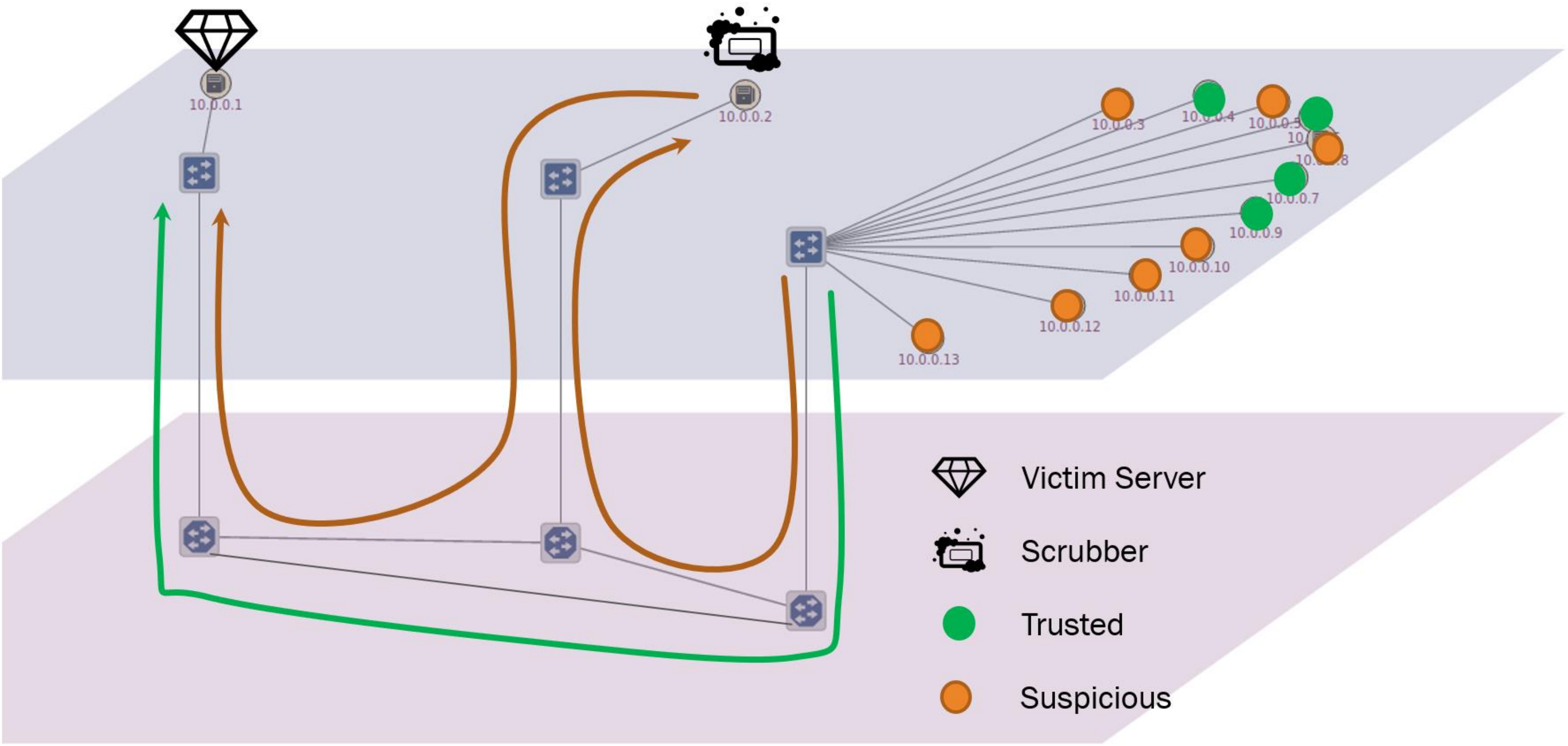

ONSET: The Road Ahead

- Demonstrate feasibility of ONSET against diverse DDoS attacks
  - Build an accurate modeling and simulation platform for ONSET
    - Model optical and electrical network components
    - Simulate fixed/variable rate attacks, volumetric, and protocol-conforming attacks
- Prototype ONSET
  - Demonstrate an ONSET system, characterized by optical switching time and performance guarantees for legitimate users during an attack
- ONSET for Advanced Cyber Attacks
  - Network reconnaissance is an ongoing threat
  - Transitioning network state between different optical layer connectivity graphs to thwart malicious reconnaissance campaigns

Questions